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THE LATE PROFESSOR CLERK-MAXWELL.

ELECTRICAL SCIENCE has sustained a severe loss in the premature death of one of its theoretical masters, Professor James Clerk-Maxwell. Maxwell's great work on Electricity may be called the Principia of the subject on which it treats, and it has carried his fame into all civilised countries. The death of its author at the comparatively early age of 48, the age when an intellectual worker is in his prime, will come upon most of those who are familiar with his name and labours with a kind of shock, for it was confidently believed by those best fitted to judge of his powers that high honours and great achievements were yet in store for him. Death, however, from whose darts the brightest genius is no safeguard, has stepped in, and put an end to these confident hopes. After an illness of a few weeks the Professor died at his residence in Scroope Terrace, Cambridge, on Wednesday, November 5.

James Clerk-Maxwell was a native of Edinburgh, where he received his schooling, and entered Trinity College, Cambridge, as an undergraduate in 1850. In 1854 he graduated as Second Wrangler, taking his B.A. degree, and was elected a Scholar of the College. In the contest for the Smiths prize he was declared equal in merit with Mr. E. J. Routh, the Senior Wrangler of that year. Next year he was elected to a fellowship of Trinity, and the following year, 1856, he was appointed Professor of Natural Philosophy in Marischal College, Aberdeen. In 1860 he came to London as Professor of Natural Philosophy and Astronomy in King's College, which chair he held until his nomination to the chair of Experimental Physics at Cambridge in 1871, on the establishment of this new chair in the University and the erection of the excellent Cavendish Laboratory for the prosecution of physical research. Here his principal duty consisted in teaching and illustrating the laws of heat, electricity, and magnetism, and in advancing our knowledge of these subjects and their study at the University. "For the last eight years," says a writer in the *Times*, "Professor Maxwell has laboured assiduously, both in term and vacation, to carry out the objects of the professorship, and has succeeded in attracting an unusual number of earnest students, many of whom have highly distinguished themselves in the mathematical Tripos. The Chancellor of the University has taken a great interest in Professor Maxwell's work, and it was through the Duke of Devonshire's munificence that the magnificent Cavendish Laboratory, over which Professor Maxwell presided, was erected and supplied with necessary appliances. So important was the study of physical science considered that in 1874 a Demonstrator was appointed to assist Professor Maxwell. By a curious provision that professorship terminates with the death of the Professor, unless the University shall determine to continue it. There can be little doubt that it will be decided to continue the professorship, although it will be extremely difficult to find a successor so eminently qualified as was Professor Maxwell."

This distinguished scientist was apparently at his best as a mathematician, dealing with physical phenomena, and as such belonged to the school of Sir William Thomson, together with Professor Tait, Dr. Joule, and others. His miscellaneous works are to be found scattered among the *Transactions of the Royal Society*, of which he was a Fellow, the *Cambridge and Dublin Mathematical Journal*, the *Transactions of the London Mathematical Society*, and those of the Cambridge Philosophical Society; but his reputation as a scientific investigator is also acknowledged by the scientific world. Besides his chief work on "Electricity" he also wrote a small handbook on "The Theory of Heat," published by Macmillan & Co., which has already run through four editions. His style was singularly lucid, terse, and yet polished, it was in short the perfection of a purely scientific style; and his superabundant wit and humour occasionally burst from the restraints of severer thought and found vent in the more liberal forms of poetry. Under the *nom de plume* of $\frac{dp}{dt}$ his physico-comic parodies of well-known verses have appeared from time to time in our contemporary *Nature*, and caused considerable amusement.

Professor Maxwell has filled the office of Examiner and Moderator for the Mathematical Tripos on several occasions. He has also been President of the Cambridge Philosophical Society, and our readers will hardly need to be reminded of the fact that he delivered the Rede Lecture on the "Telephone" last year, a lecture which was not only an exquisite model of its kind, but the most searching exposition of the subject which has yet appeared. He was an Honorary Fellow of Trinity College, a distinction which he shared with the Astronomer Royal, the Poet Laureate, and Lord Houghton.

WE are requested to state that the Picton Reading Room, Liverpool, is being illuminated by the British Electric Light Company by Serrin lamps, and not by Werdermann lamps, as stated in our issue of Oct. 15.

A CHLORIDE OF LIME BATTERY.

By ALFRED NIAUDET.

THIS battery has for its positive electrode a plate of zinc, and for its negative electrode a rod of carbon surrounded by fragments of the same material.

The zinc is plunged into a solution of common salt; the carbon is placed in chloride of lime contained in a porous cell of either porcelain, canvas, or parchment paper.

The chloride of lime is, as is well known, a mixture of hypochlorous acid and lime; the acid seems well suited for depolarising the negative electrode, because its two component parts can both of them combine with hydrogen to form, on the one hand, water, and on the other hand, chlorohydric acid. This acid can attack the zinc and produce chloride of zinc; or it can attack the lime and produce chloride of calcium; these two salts are very soluble and very good conductors of electricity. The choice of the substances employed is such that the combinations which take place are soluble and conductive. It is possible that certain double salts are formed, as is the case in all batteries; but if this is the case they are soluble, as experiments with the batteries show.

The zinc in the presence of the chloride of lime is not sensibly attacked, and consequently batteries with these elements can remain for an indefinite period without waste; action only commences when the circuit is closed. This property is, as is well known, of great importance in many cases.

We will now consider the reason for employing chloride of sodium; the advantage is, that it is the cheapest of all salts without exception. The solution is the best liquid conductor known. But there is still another advantage: a great number of other salts and other liquids have been tried, notably sal-ammoniac, the hypochlorite of soda highly concentrated, the chloride of lime, diluted sulphuric acid, but all have given less satisfactory results and a lower electro-motive force than common salt. The reasons of these inferiorities are undoubtedly very various; the defect appears to arise from the formation of an insoluble sulphate of lime which stops the further action of the battery.

The electro-motive force of the new battery is found by experiment to have a maximum value of 1·6 volts., which falls to 1·5 after several months' use.

The depolarisation produced by the chloride of ime is not complete or instantaneous, as it is in sulphate of copper batteries; if the battery is worked through a low external resistance the electro-motive force falls, as is the case with almost all batteries. But this force regains its normal value quickly. In an experiment, the electro-motive force being found to be equal to 1·39, the circuit was closed through a resistance of 1 ohm for 40 minutes, the force was then found to be reduced to 1·13, but at the end of 40 minutes, the circuit being open, it had risen to 1·29, and in two hours to 1·38.

The internal resistance of the battery is comparatively low; great care having been taken to reduce it as much as possible. The zinc is placed very near to the porous cell and completely surrounds it; but is prevented from touching by a simple device.

The smell of the chloride of lime is hardly sensible even with the ordinary batteries, because care is taken to seal the porous cell at its upper part with asphalte, which protects the salt from the air and at the same time keeps it securely in the cell. The outer cell can also, if necessary, be hermetically sealed, as is sometimes done with other batteries.

THE IMPROVEMENTS SCIENCE CAN EFFECT IN OUR TRADES, AND IN THE CONDITION OF OUR WORKMEN.*

By PROFESSOR W. E. AYRTON.

TRADE is bad, horribly bad! The causes of this depression, which meets us on every side, it is not difficult to ascertain—inability to compete with the foreigner in the production of what England consumes, combined with inability to trade economically in his own markets. We cannot, for example, now grow corn or rear cattle as economically as we can get them from America; so that while our land produces ten million quarters of wheat a year, we import as much as thirteen millions, whereas thirty years ago we grew fourteen millions (more, in fact, than at present), and imported only four million quarters per annum.

On the other hand, the Americans can manufacture machinery cheaper than we can sell it to them, in consequence of their high import duty of about 30 per cent.

We might say that this state of things arose from their having on the other side of the Atlantic vast pasture lands, a good climate, and protection; while we are cramped for room, inundated with rain, and luxuriate in the blessings of free trade.

It is not, however, only the demand abroad for English commodities that we see slowly dying away, but we find that even in our own country we are being gradually undersold in those productions which depend not on pasture lands, not on climate, but on the use of labour-saving machinery—the result of human ingenuity.

Our disappointment in witnessing the gradual disappearance of the foreign market for our manufactures may possibly be alleviated by our belief that the example we are setting of perfect freedom in trade will be ultimately for the world's good. But no ray of consolation can cheer the remembrance that our Coventry ribbon trade, that once famous industry created by ourselves, has well-nigh departed to Switzerland in company with the silk weaving industry of Lyons and Spitalfields. The Clerkenwell mechanic sees with no feeling of national pride the American machine-made watches pressing on his heels in the march of time. Even our trade in the bending of umbrella and stick handles is rapidly crossing the Atlantic, and several of our chemical industries are being absorbed by the Continent.

And what about those devices, those Yankee notions, as we call them, in which machinery replaces the old cumbersome and uneconomical hand labour—the sewing machine, the type-writer, for clear and rapid correspondence, the electric pen, for superseding lithography, duplex and quadruplex systems of telegraphy for multiplying the carrying capacity of a telegraph line, and that instrument for dispensing even with messengers,

* The Inaugural Address, delivered at The City and Guilds of London Institute, on Saturday, Nov. 1st, 1879.

the telephone. Why, not only do these come to us now from America, but it was in that country that they all sprang into existence, with many brothers and sisters like themselves. I shall, no doubt, be answered that it was to that country that they all owed their birth, because American labour is so dear, and, consequently, some means must be found to economise it. You might imagine from this there was in America a national evil—dear labour—and that machinery had to be devised to overcome its ill effects. But do high wages necessarily mean large selling prices of manufactured goods? What foremen in this room, wishing to turn out articles well and cheaply, would prefer employing an ignorant Indian labourer at say twopence a day wages, instead of an English mechanic, with his knowledge of tools, at six shillings a day. So, in the same way, a highly paid American workman may, with his most ingenious labour-saving machinery, undersell the English in their own market. One of the things, therefore, which England requires, in order to regain her old commercial supremacy, is smaller cost of production of manufactured articles, a condition of things which, I think, you see, is not at all incompatible with higher wages.

In my British Association lecture to the workmen of Sheffield, this year, I have experimentally shown how an enormous economy can be effected in the consumption of coal, and, consequently, in the cost of generating power, and in the working of the metals, as well as in the expense of warming and lighting your buildings, by the employment of very large steam-engines and of natural sources of power, such as streams and waterfalls, and by conveying, through the agency of electricity, this power to the distant places where it was required to be used. For water power, if sufficiently far away from a town, is often worth little or nothing, since the cost of conveying the work done on the spot over the hilly country to the markets more than compensates for the economy of using water instead of steam; but the waterfall, if utilised for transmitting power into the towns by electric currents, becomes much more economical than burning coal. Again, as I explained to my audience, work done by distributed power from a very large steam-engine, would be much cheaper than using a number of small steam engines, if only the power could be distributed without the great waste which always accompanies the friction of shafting, leather-belts, tooth-wheels, &c. Now, if by means of what is called a dynamo-electric machine, we convert the work done by the one large steam-engine into electricity on the spot, and convey, by means of wires, this electric current to different points, and there, with dynamo machines worked backwards, we re-convert it into motive power, then the loss of energy by friction, &c., can, with the special form of working I explained, be reduced to something like thirty per cent.

As a small illustration of what I mean, I will show you the following experiment:—When I turn the handle of this machine, my muscular energy is converted into electricity; the food that I have eaten is burnt up in my body, and its equivalent—a current of electricity—is produced. This electric current, by means of the copper wires before you, is conveyed across the hall to that other machine, similar to the one I have here. In that distant machine, the electric current is converted back again into mechanical motion, and the work given out there can be practically made use of—for turning, for example, that sewing machine.

In the same way, but on a much larger scale, we ground knives on the platform of the Albert-hall, Sheffield, turned a lathe, sawed thick planks, electroplated, and lighted the building, the power for doing this being all supplied by a steam-engine a quarter of a mile away. Coal was put into the furnace of the steam-engine at one end of the long copper wires, and work was given out at the other ends of the wires in the Albert-hall.

But the importance of this principle of the electric transmission of energy, like that of many other simple principles, while grasped by foreign engineers, is almost unknown to the British public. Last year, in order to gain the advantage of ploughing by steam, while at the same time to avoid the disadvantage of pulling a heavy steam-engine into rough fields, two French engineers, MM. Chrétien and Felix, ploughed by electricity. A plough was used having two sets of shears, so that it could be used going forwards or backwards without turning. This plough was pulled across the field, first one way and then the other, by dynamo-electric machines, stationed one on each side of the field. These dynamo-electric machines were driven alternately by an electric current, conveyed to them by wires coming from a third dynamo-electric machine on the hard road some hundreds of yards away, and to which motion was given by a steam-engine placed beside it. A photograph, taken on the spot, of the plough and one of the dynamo machines, I now project on the screen. We will next look at a second photograph of a drawing of M. Chrétien's electric crane for unloading boats. This also has been successfully employed for several months in the harbour of Sermaize, France, and it is considered that a saving of about thirty per cent. has been effected in the expense formerly incurred for unloading the sugar barrels out of the boats.

When one of our leading telegraph engineers, Dr. Siemens, has urged so strongly the economy of this electric transmission of power, it may appear inconsistent for me to say that the British public do not realise in the least the value of this new principle, and needless for us to fear that their conservatism will throw considerable obstacles in the way of its general adoption; but then we must remember that Dr. Siemens is a German, and was probably educated in a German Polytechnicon, or in some institution realising the value of technical education, and affording the means for imparting it.

At Sheffield it was the economy of utilising the present wasted natural sources of power that exist in our mountain streams that I urged on my large audience; to-night it is the utilisation of even a still more important dormant natural source of power—man's brain—that demands our close attention.

It must sometimes have puzzled you why a successful professional man, one who has no manual skill, no strength of limb, earns, by his work, so much money, and what is higher, so much fame. It must sometimes have struck you as, at the very least, rather hard that while you are toiling from morning to night, day after day, to gain only enough to live on, another, by the mere efforts of his thought, amasses a fortune. But you, no doubt, regard it as quite fair that a skilled mechanic should receive higher wages than a navvy. For you say that although he has eyes and arms, like yourself, and is, perhaps, the stronger of the two, still you can use your powers with a skill of which he knows nothing. Now, just as he has muscular strength, which, when cultivated, means wealth to himself and his country, so you have brain power, which only requires education to fit it to do useful work. But you will say, am I not forgetting you have all been to school, and have received an education at least as good as is given in the Board schools. Consider, however, what is taught in these schools where masses have to be educated. Is there time to teach reflection, to foster the reasoning power? Is there that training

given you which should make you unwilling to follow any special routine method in your trade, unless you are convinced it cannot be improved on? And can you expect it to be otherwise when the boys and girls leave at 12 or 13 years old, when the main object of the teacher, who is paid by results, is to cram the young until they are heavy enough to drop through the examining machine, when occasionally the teaching is necessarily confined to the three R's, solely because the Government inspector finds that other subjects are—well, a little beyond his limited attainments. Again, what is the feeling boys and girls have at the national schools? If they succeed in their lessons, they look forward to becoming pupil-teachers; but if prizes do not fall to their share, they feel that teaching is not for them, and fall back on a trade; but how very few, if any, ever look to their studies as a means of making them educated workmen, instead of mere copying machines.

The consequence is that, when a lad is first apprenticed, he is merely an errand boy, or fag; being fit, in fact, for little else. Subsequently he is posted in one of the departments of the manufactory, his instructor being the man under whom he works; but this man, having his own work to attend to, has not time to teach, and, even were it not so, he could only show the boy the manual operations.

When the piece of work on which the apprentice has been engaged is finished it has to pass the foreman of the department; generally a man who, through honesty, sobriety, and manipulative skill, has risen from the ranks of the workmen, and whose education has been of a character similar to those around him. The foreman's duties, of course, leave him no time—even if he were competent—to give instruction, and thus the lad goes on, probably working, quite mechanically, at only one small branch of his trade. In time he becomes a journeyman; he may become a foreman, to govern others. Thus the "rule of thumb"—viz., each man working as his shopmates do—proceeds, and thus ignorance of principle has been carried on from one generation to another. And things go on remaining very much as they are, merely because we have never seen them otherwise.

The man or woman, then, instead of becoming an agent far above any machine—in that there should be the possession of the reasoning power, which is a quality of no machine—frequently finds him or herself, mentally, infinitely inferior to Babbage's calculating engine; bodily, quite unable to work with the accuracy and speed of, say, an automatic lathe for turning gun-stocks; and, from having a knowledge of only one narrow department of one restricted industry, is quite at the mercy of the fluctuation of trade for the means of subsistence.

But, do not let it, for the moment, be thought that I am regretting the Education Act of 1870, or am, in the least, blaming the necessary course taken by the school boards, since nobody is more alive than they are themselves to the incompleteness of the present education of the English artisan. That may be seen from this year's report of the Educational Endowments Committee, in which it is recommended that the city parochial charities shall be employed for the establishment of technical schools, to be attended by boys and girls for the two years after leaving the existing schools, that is, during their fifteenth and sixteenth years. It is not necessary on the preseent occasion to refer to the suggested curiculum of such technical schools, beyond saying that it appears to be complete.

It ought to be tolerably clear to every man, that it is important for him to have a good knowledge of the fundamental principles that govern the processes employed in his own trade. For example, when it is remembered what great mechanical differences are produced in iron by the admixture of even small quantities of carbon and by varying the temperature of hardening and annealing, the steel manufacturer will see at once the importance of the study of chemistry to him. In these pieces of steel which I hold in my hand, and which are all quite soft now, the smallest amount of carbon is less than one-tenth per cent. and the largest amount only one-and-a-half per cent., but if I heat all three pieces red hot and plunge them into cold water, the first, you see, remains quite soft, while the second has become springy, but the third is glass-hard, so that it shivers to pieces when I try to bend it. But if I had kept them heated white hot for some time, I should have burnt out the carbon, removed the steely nature, and spoilt them. If, again, after heating the specimens of steel red hot, I had cooled them very slowly, they would, as you all know, have been found each of them quite soft as they were originally. Now, many of us believe steel is far better for our bridges than iron, but the fact that such very slight differences in the chemical composition and the mode of cooling change so marvellously the mechanical strength without materially altering the weight or the general external appearance of the material, renders any system of testing the quality of the completed girders a difficult problem, and so while on the one hand we are still chary of using steel for bridge purposes, on the other hand the chief manufacturers and chemists are closely turning their attention to the difficult problem of producing steel in large quantities of identically the same chemical and mechanical quality throughout.

So, in the same way, a man engaged in telegraphy, or in any of the various trades connected with electricity, understands the importance to himself of a knowledge of electricity, for he has such facts constantly forced on him as that the difference of the hundredth of an inch in the position of a wire means the difference between a telegraph line in good working order and a total interruption. For example, this electro-magnet which we have on the table has now the power of holding up masses of nails, because an electric current is flowing round its two arms, but if I make a breach in the wire, and keep the two ends separated by even an exceedingly small distance, or if I even press the ends together, leaving, however, a bit of paper or some dirt between them, the electric current is so much weakened that the electro-magnet, as you see, has practically quite lost its power.

Or, again, such facts that metals expand when heated, as you see does this brass ball, so that it will not pass through the brass ring it slipped through when cold, are of importance to every wheelwright, to every caster in metals, &c.

But something more than mere special knowledge is of importance to each man, for the object of education is to develop the mental powers; the acquisition of knowledge I regard as of but quite a secondary importance. Let a man but acquire the art of learning one subject properly, and the groundwork of his education is to a great extent completed, since he will naturally afterwards be always seeking for knowledge from books, from teachers, from nature, in all those branches which at any time may be of importance to him.

It is of much importance that a correct notion of the real aim of education should be impressed on you to-night, when we are here to inaugurate the commencement of that wide scheme of technical education which the City and Guilds of London have, after mature deliberation, generously seen fit now to enter on. In the future, we hope to have special classes for a variety

of technical subjects, and we shall look to you, guided by your own wants, to choose for us, to a great extent, what those subjects shall be; but, just for the present, we must be contented with only a few branches of technical education. Do not, however, run away with the mistaken notion that because I commence my first course of lectures on Monday next, in this building, on "Some of the Practical Applications of Electricity and Magnetism," that, therefore, if you are a watchmaker, or if you are a boiler-fitter, or if you are a coach-builder, you can have no concern with what will be taught. Do not say I shall never put up an electric bell; and, as for electric lights, why, in these hard times, I have hardly money enough to pay for tallow candles. If I were merely going to explain to you how an electric bell was made, and how it could be fitted up in the cheapest, and, commercially, best way; or if, again, in my lectures after Christmas, on "The Elementary Principles of Mechanics, as exemplified in our Clocks and Watches," I was merely going to tell you more dodgey ways of making cheaper watches; you might well say, if your particular trade was not concerned, "That's no good to me," and stay away. But when I tell you that, from the wide range of technical physical subjects from which the choice had to be made, electricity was selected to start with because it was a subject that had been so prominently before you of late, and the mechanical science of watches has been advertised to follow it, because a watch is a machine you nearly all of you possess, and can, therefore, examine for yourselves; and when I assure you that the fundamental truths that will be elucidated by experiments from these branches of inquiry will be of no less importance in the advancement of carpentry, printing, and turning than for improvements in electro-plating, watch-making, and the allied trades, you will see that coming to these lectures is a duty you owe to yourselves and to your country, and you will conclude, I hope, very many of you, that "since the City is generous enough to offer its money to help my education, I have ambition enough to come and learn."

I have said that the main object of education is the mental training which it ensures, and, as a proof of how very much more important this is than any mere accumulation of facts, may be seen from so many inventions having been made by minds which, although educated, had but a small knowledge of the special details of the science to which the invention belonged. Take, for example, the Bell's telephone; it was not any very extensive acquaintance with electrical apparatus that enabled Prof. Bell to invent this apparatus. Nor, again, was it a wide knowledge of the laws of acoustics that led Mr. Edison to successfully devise the first practical talking machine, the phonograph. And, thirdly, it was not any special knowledge of telegraphy that led Mr. Cowper to invent his "writing-telegraphy," and similarly with several other discoveries.

We may say that the invention of the Bell's telephone depended on the inventor, during his investigations of the experimental methods of determining the natural pitch of vowel sounds, seeing that magneto-electricity (that is, the generation of an electric current by the motion of a magnet near a coil of wire) realised, as Sir William Thomson puts it, "the mathematical conception that, if electricity is to convey all the delicacies of quality which distinguish articulate speech, the strength of its current must vary continuously, and, as nearly as may be, in simple proportion to the velocity of a particle of air engaged in constituting the sound."

Magneto-electricity, as you no doubt all know, was discovered by Faraday, and is one of the most beautiful examples of the importance of studying elementary principles. Faraday was not a student at a university, spending money and time in learning the conventional accomplishments of a gentleman, but he was the son of a blacksmith who had, by hard work, to earn his own living. I have no time now, I wish I had, to tell you about the life of that one of England's heroes who spent it in fighting against and vanquishing scientific difficulties in order that the world might add to its possessions a new and unknown land of scientific discoveries. But I will say just one word about this discovery of magneto-electricity, since on it depends all the electric lighting of the present day, and all the electric transmission of power—that vital question of the future.

Faraday knew that motion could produce electricity with the ordinary glass electrical machine, and that the electricity so produced could, in its turn, set up motion, as in the pith ball telegraph worked by Sir Francis Ronalds. He knew that difference of temperature could produce an electric current, and the electric current could in its turn produce heat, or difference of temperature. Consequently Faraday felt sure that, since an electric current can, as you have seen, produce a magnet, a magnet must, in some way, be able to create an electric current. But his attempts were baffled time after time; failure, failure only was the result, yet buoyed up with hope, still persevering with that dogged earnestness which is the characteristic of an Englishman, he at length arrived at this all-important discovery—to produce a current with a magnet it is no use placing the magnet this way or that way relatively to the coil, but you must have *motion* of the one relatively to the other.

Here we have a vertical copper wire, up or down which we can send an electric current, produced by a battery outside the room. Behind the wire there is a magnet, suspended on a horizontal axis, so that it can turn in a vertical plane. The magnet is so arranged, that usually it stands upright, but if I send a current upwards, you observe this end turns to your left, while if I reverse the direction of the current the same end now turns to your right, the magnet in both cases placing itself at right angles to the wire.

Such an arrangement then is a detector of a current, but it is rather a rough one, and only indicates the presence and direction of large currents. But this other instrument, in which the wire goes many times round the suspended needle, is more sensitive, and as the deflection of the magnet is indicated by the motion of a beam of light reflected from a small piece of looking glass stuck on the magnet, the presence of very small currents may be detected. To the two ends of the wire forming the current-detector are attached the two ends of the wire forming this coil. The spot of light is now in the centre of the scale, indicating the magnet is undeflected, or that no electric current is passing; but if I rapidly move towards the coil this magnet which I hold in my hand, the spot of light is deflected to the left, and then comes back to the zero position, indicating that an instantaneous electric current was set up in one direction. Now, if I rapidly remove the magnet I have in my hand, you observe that the spot of light swings to the right and then comes back to zero, indicating an instantaneous electric current in the opposite direction.

When Faraday first made this discovery in 1831, I have no doubt many people thought it a very pretty scientific experiment, but not likely to be of any practical use. Yet to what a host of practical purposes has it been applied during the last forty years. We now see that the invention of the galvanic battery, such as we are using for producing the electric light in this hall, is beginning to sink in importance before magneto-electric induction; for how do we get those strong currents to produce the electric lights of the present day on the Thames Embankment, Waterloo

Bridge, the British Museum, or nearer still, in Aldersgate station? By magneto-electric induction. How do we get these sparks with this Ruhmkoff's coil which enables us to imitate lightning on a small scale, and so to devise by experiment lightning protectors for our telegraph lines? By magneto-electric induction. Magneto-electric induction is used not only in the Bell's telephone (one of which you now hear on this table giving out the ticking of that clock by the aid of Hughes' microphone, and another of which you see employed with this Hughes induction balance, by means of which two grains of gold can be detected in a pound of silver, solely by the slight electrical change so small an admixture of gold produces throughout the whole mass), not only, I say, is Faraday's principle of magneto-electric induction employed in all these wonders, but it is made use of in the Edison's loud-speaking telephone which you now all hear telling you the words spoken to it by a man in a house in Tabernacle Row.

But, besides magneto-electric induction, Mr. Edison employs two other most ingenious principles in order to fulfil the necessary condition of every instrument used for electrically transmitting human speech, viz., that the strength of the electric current must be nearly proportional to the velocity of the particle of air engaged in constituting the sound. The first of these principles, discovered by him in 1872, is, that the passage of electricity, from one body to another resting on it, diminishes, in certain cases, the friction between them, and allows slipping to take place more easily if they are pulled one over the other. For example, if I am pressing a piece of platinum attached to the zinc pole of a battery, as in the figure, on to a piece of paper moistened with a dilute solution of hydrogen disodic phosphate, and attached to the copper pole of the battery, then if a pulling force be applied to the paper, a little less than that necessary to make it slip, it will be found that slipping will take place whenever the key is pressed down, so that the electric current is allowed to flow, and the paper will stop again each time the circuit is broken, so that the current is stopped. Already this principle has enabled Mr. Edison to convert his motograph or telegraph-receiving instrument without electro-magnets, and, it may possibly be found to have some connection with the comparative inefficiency of railway brakes when skidding takes place, that is when the rotation of the wheels is entirely stopped. But most important of all, Mr. Edison, by means of it, was enabled to devise his "loud speaking telephone," when the Bell Telephone Company would not allow him to make use of theirs. Inside this instrument there is a cylinder of compressed chalk, A in a figure, moistened with the liquid I have already referred to. C is pressed on to the chalk cylinder, so that when the chalk cylinder is rotated, C is, by friction, pulled a little onwards, and the diaphragm is stretched. If, now, an electric current, coming from the distant station, passes from the strip, C, to the revolving chalk cylinder, A, the friction is lessened, and the diaphragm springs back, and thus swingings of the diaphgram are set up exactly in time with the alterations in the strength of the electric current. But how does Mr. Edison make these variations of strength of the current time with the sound waves emitted from the speaker's mouth? By utilising another very pretty principle—that carbon opposes less resistance to the passage of an electric current, becomes, so to say, more porous to electricity, if you squeeze it. A galvanic battery sends a current through a piece of pressed carbon at the speaking end, and the sound waves emitted by the speaker's voice strikes this carbon, and press it more or less, making the current stronger or weaker.

Next, let me draw your attention to the American Stock Printing Telegraph, of which we have specimens in this hall receiving and printing messages sent from a house in Tabernacle Row. This instrument, in that the paper is started running, the message is printed, and the paper stopped again when the message is finished, all by electric currents coming from the distant station, and without any control of any kind at the receiving end, may be looked upon as wonderful, even for an American invention.

Look again at Cowper's writing telegraph, some specimens of the production of which are now handed round the room. It is a well known principle that any motion along a plane may be regarded as the result of two motions at right angles to one another; any motion of a fly, for example, crawling along a wall, is so much movement up or down, combined with so much movement sideways. With these two levers working at right angles to one another, and conjointly moving a pencil, I can write what I like, or, if properly controlled for me by these cams, they will write definite letters, in this case, "W. T.," Mr. Cowper's initials. This idea is employed in defining the position of a place on the earth's surface by its latitude and longitude, it constitutes the whole of the science called *analytical goemetry*, which has been of so much service in all branches of modern scientific advance. And yet it does not seem to have occurred to telegraph engineers that all ordinary writing can be compounded of two motions at right angles to the two edges of the paper, and, by well-known electric principles, can be exactly reproduced and compounded at a distance, producing a facsimile at one end of the line of what simultaneously is written at the other. Technical education being what it is, it is not surprising that this electrical invention should have been made by a mechanical engineer and not by an electrician.

We might, did time only allow, go on multiplying indefinitely examples to prove that a *general* knowledge of elementary principles is of the greatest importance to every man, whatever be his trade. George Stephenson, but a coal miner, and yet the practical inventor of the present locomotive engine, understood that fully. No Institution for the Advancement of Technical Education was founded for him, no City companies lent him a helping hand, and yet he set himself to study the principles of mechanics when he had only just succeeded, with great difficulty, from his absence of leisure and instruction, in teaching himself to read and write, as he sat by the engine fire. The account of his experiments to discover a form of miner's safety lamp is a living exemplification of the rule attributed to Bacon, but, in reality, given long before by the painter Leonardo da Vinci:—"Begin with observations, go on with experiments, and, supported by both, try to find a law and a cause." Starting with his own idea that, in order to prevent fire-damp exploding, it was necessary that the gas should pass through the lamp at a certain velocity, Stephenson arrived, after many experiments, at the all-important result, discovered quite independently by Sir Humphrey Davy, that wire gauze, if the meshes are of sufficient fineness, cuts, as you see, a mass of gas into two portions, one of which can be ignited without the other catching fire or exploding.

And, realising so fully as he did the advantages of education, it is not to be wondered at that he strained every nerve to have his son Robert well taught, and even sent him to Edinburgh University, where, in six months, he is said to have acquired as much knowledge as takes many ordinary students three years to learn. And why to Edinburgh University, and not to some nearer English college? Because, at that time,

there was no institution where the means of a man like George Stephenson, only one step removed in position from that of an ordinary miner, could obtain even a decent scientific education.

And what has been the result of this cheap and general Scotch education spread over many years? Why, that we now see so many posts at home and abroad held by Scotchmen, just as we find a considerable portion of the more important positions in our manufactures occupied by young Germans solely on account of the scientific training they have received.

What were the feelings Professor Bell had when in England. He wrote to America:—"If you want to know why inventors are more numerous in America than they are in England, come and live for six months in England. If you wish to know what it is to be brimful of ideas, and yet to be unable to have them executed, come to England. Masters, instead of encouraging invention, do all they can to put a stop to it, by charging the most exorbitant prices for experimental work, avowedly because they don't want such kind of work, because it gives, they say, more trouble than it is worth," and much more of the same nature.

Now granted, if you like, that this is much exaggerated, granted, even if you wish, that it arose from national prejudice, still we must remember that Bell himself was an Englishman, and the inventor of one of the most wonderful instruments of modern times. Also, we must not forget that George Stephenson's attempt to survey the route for the Liverpool and Lancashire Railway led to his being frequently stoned by the inhabitants of the property, who have since most largely benefited from his work; and that Sir Francis Ronalds' letter to the Secretary of the English Admiralty, in 1816, describing the electric telegraph that Sir Francis has constructed, and successfully worked, led to an answer, splendidly calculated to foster invention, viz.—"Mr. Barrow presents his compliments to Mr. Ronalds, and acquaints him, with reference to his note of the 3rd instant, that telegraphs of any kind are wholly unnecessary, and that no other than the one now in use" (that is the semaphore) "will be adopted."

If England is, then, so lamentably deficient in technical education, how is it that English engineers, English workmen, have hitherto been considered first in the world? Because we started earliest in the race, because we had an abundant supply of coal and iron, and, lastly, because we had an indomitable energy; but Dr. Lyon Playfair, some years ago, asked this question, and the present depression in trade leads me to ask it again now:—"Do you sincerely think that the country can continue in a career of prosperity, when she is the only leading State in Europe that is neglecting the higher education of the working classes, and of those men above them whose duty it is to superintend their labour? It is a truth incapable of being gainsaid, that science must be joined to practice in the advancing competition of the world, in order that a nation may retain the strength and energy of manhood; for States, like individuals, fall into decrepitude and decay." Dr. Lyon Playfair has been answered; answered sooner, and in a more decided manner, than even he could have feared; and that reply is, No! our country has, indeed, not continued in its former state of prosperity. Years ago France, Germany, and, above all, Switzerland, set themselves the same question; but instead of waiting, like ourselves, for time to give the sad response, they foresaw it, and, by fostering technical education, have absorbed into their country some of the industries of the world. The city and canton of Zurich, having once grasped that their system of national education was defective in modern practical science, vied with each other in providing funds for the complete equipment and support of a technical university. They did not, as Mr. Scott Russell tells us, ask themselves "what is the smallest and least costly scale on which we can begin to make good a few technical deficiencies?" but they asked themselves that other question, "what is there in the science, the philosophy, the learning, the art, and the practical skill of modern times, which can be learnt and taught, but for which there is no adequate provision already made for teaching to our students in the universities of our land?"

And yet another nation, small and apart from the world, a people like the Swiss, dwelling in a mountainous country, and like them too dearly loving their pine-clad hills—the Japanese—have set us an example that our ambition should lead us to emulate. Much have we heard of Japanese art, much have we seen of Japanese lacquer, Japanese fans, but only a few of us are acquainted with the Japanese modern technical education. Ten years ago a feudal country, tyrannised over by barons, with power of life and death in their hands, distracted by the conflict between the rightful sovereign and their hereditary military usurper, that nation whom we regarded as barbarous, that nation of whose manners we were comparatively ignorant, whose very modes of thought are so different from our own that we can be hardly said to understand them now, that people had but three years emerged from a state of almost slavery, when up grew, in its very midst, a technical college, with its staff of carefully chosen English professors, with its laboratories, class-rooms, museums, libraries, and workshops, costing Japan, a poor country be it remembered, at least twelve thousand pounds a year to support, and many many thousands to build. And to enter and study at this college, neither money, nor position, nor any qualification is necessary but ability and desire to study; so that working at the lathe, or conning over their books in the class-room, or experimenting in the laboratory, may now be seen, side by side, the young noble and the young artisan.

An example to emulate did I say? The City companies have given us the opportunity, let us show that we appreciate it. They do not propose merely to teach each man his trade or business, for that he can best learn in the workshop or counting-house, nor have they any idea of merely grounding you in elementary arithmetic, since that you can learn at school; they do not start by building handsome edifices, although they have subscribed many thousands for erecting in London a large central technical college, but what they have done is to henceforth put on one side more than fifteen thousand a year of their own money to give you from now that education which will enable you to commence doing what George Stephenson, in these words, half a century ago, urged on you:—"Learn for yourselves, think for yourselves, make yourselves masters of principles, persevere, be industrious, and then there will be no fear for you."

HICKLEY'S PATENT AUTOMATIC ELECTRIC LAMP.

THE distinguishing features in this lamp are its extreme simplicity, the ease with which the carbons are replaced by fresh ones when required, and the manner in which the length of the arc can be adjusted to suit the number of lamps to be put into one circuit; also the cheapness at which it is produced is no small feature in its favour.

Fig. 1 is a plan and fig. 2 a side elevation of the lamp. L is a lever which works between two

screws in the frame F F. At one end of this lever is fixed an iron armature over the electro-magnet M, at the other end is an arbor on which are fixed a ratchet wheel C and a disc of carbon C, the latter being about four inches diameter and one inch thick. The adjusting screws are so placed upon the frame F F as to prevent the armature end of lever L rising too high or the disc at the other end falling too low; this screw regulates the length of arc, for if the disc C is allowed to rise and fall a $\frac{1}{4}$ inch the arc will be $\frac{1}{2}$ inch long, or more or less as required. The frame carries an insulated terminal T, which is connected to one end of electro-magnet, the other end of which is attached to the frame F F itself. At the end of the frame is a pawl P for the

Fig.1

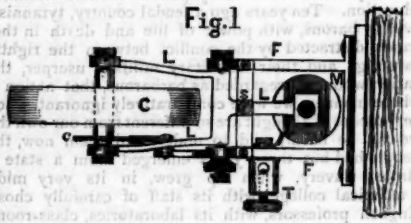
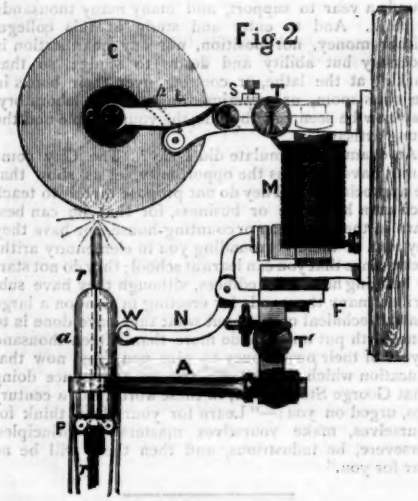


Fig.2



purpose of turning the disc of carbon every time the latter falls and rises. At the lower end of the frame under the magnet is an arm A (fig. 2) carrying a cone piece cut vertically in two pieces, one piece coming off inwards and kept in its place by steady pins; a conical hole, larger at the bottom than at the top, runs through this cone, through which the rod of carbon R passes, the latter being raised by pulleys P with a cord and weight (not shown). The hole through the cone not being large enough for the carbon, the loose half becomes forced away; but this latter is pressed by the wheel W (when a current is passing) so as to prevent the carbon rising. The other end of the lever N has an iron armature, which is attracted by the lower end of the electro-magnet M. The arm A carries a terminal T'.

The action of the lamp is as follows:—The ball or disc of carbon C falls by its own weight as low as the adjusting screw S will allow, whilst the lower carbon is raised by the weight until it touches the disc; the current then immediately passes from terminal T on top of frame through the coil of the electro-magnet to the frame and thence to the disc of carbon on to terminal T'. The iron armature on the locking lever at the bottom of the coil and the armature on the top lever L are both attracted by the electro-magnet, the lower one rather sooner than the top one, being nearer the pole of the magnet. The lower carbon is by this means locked or prevented from rising any higher, the disc rising until the armature nearly touches the electro-magnet, thereby producing the arc. When the lower carbon shortens so as to weaken the electro-magnet, and thus to lengthen the arc, the disc falls as low as the adjusting screw will allow, whilst the lower carbon rises until it touches the disc, or until the arc is shortened sufficiently to cause the magnet to again raise the disc, when the current again passes until more of the lower carbon is required, when the same action takes place again; but so rapid is the action that it is scarcely visible. At each movement the disc is turned one or more teeth, thereby exposing a fresh surface to the action of the current.

We had the pleasure of seeing Mr. Hickley experimenting with two of these lamps in one circuit, and, although they were but early specimens, and necessarily not quite perfect in finish, they burnt with considerable steadiness.

THE ELECTRIC MOTOR OF M. MARCEL DEPREZ.

By E. HOSPITALIER.

THE question of electric motors, as of steam motors, divides itself into two perfectly distinct parts: 1st, the production of electricity; 2nd, the utilisation of electricity for the production of motive power. It is towards the second part of the question that the apparatus of M. Marcel Deprez has made great progress, and it is this point which deserves close attention.

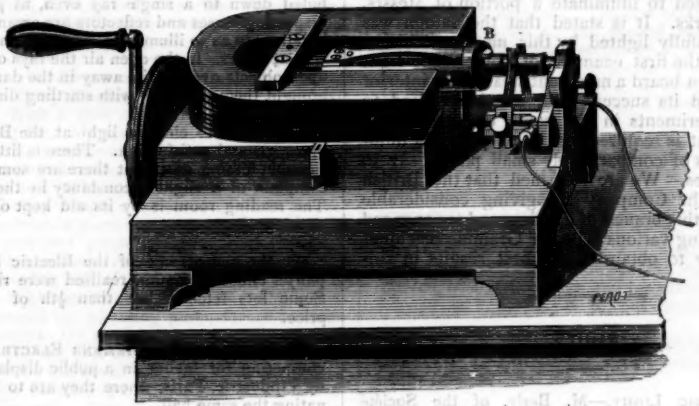
We shall first describe the motor, it will then be easier to point out the advantages which it possesses.

The apparatus is composed of a compound horse-shoe magnet formed of eight magnets; these magnets have a much greater power than those found in a single piece of a similar total weight of metal. Between the poles of this magnet is placed a "Siemens' armature," the axis of which is parallel to the arms of the magnet. This armature is a cylinder of soft iron, with two longitudinal grooves, in which is wound insulated wire, the two extremities of the wire are connected to a commutator against which rub two wire brushes, as in the Gramme machine. The *rôle* of the commutator is to change the direction of the current at each half turn.

The current which traverses the wire of the armature B produces in the latter two poles of great length which change their condition at the moment when they commence to pass before the poles of the magnet. The poles of the same name repel one another, those of opposite names attract, so that it is easy to see that the armature obtains a movement of rotation which depends upon the direction of the current which traverses it. The commutator brushes are mounted on a support which can be turned around the axis of the armature, this enables the range of the apparatus to be easily adjusted, so that the speed can be changed within wide limits.

In the small model shown by the fig., which is drawn to one-fourth scale, the magnet is composed of eight plates weighing 1,700 grammes, the armature weighs 400 grammes, and the whole apparatus about 4 kilogrammes.

The normal velocity of the armature is 3,000 turns per minute, which corresponds to 100 charges of the current per second in the armature B. The pulley, which is seen to the left of the fig., makes 100 turns per minute; the pulley can be connected by a simple gut-cord to any machine the apparatus may be required to turn, such as sewing machines,



&c. To this apparatus M. Deprez has added a peculiar arrangement which constitutes an excellent regulator of velocity. If the rotation tends to become rapid, in consequence of an increase in the electric current or by a diminution in the work to be done, a little spring connected at one end with one end of the wire on the armature, and which presses against the commutator so as to make connection with the latter, flies out by centrifugal force and breaks the contact. The circuit being thus interrupted remains so until the speed of rotation of the armature diminishes and allows the spring again to make contact. This arrangement is so sensitive that the speed of the apparatus can be preserved within a limit of $\frac{1}{100}$th of the normal velocity.

We give below some results of some experiments made at the workshops of the late M. Ruhmkorff, with the kind permission of M. J. Carpentier, the constructor of the apparatus; experiments which show the remarkable power of this motor. In these experiments the source of electricity was a Bunsen battery of the Ruhmkorff model, the cells being joined up for intensity. The figures in column 2 are those obtained with the small model just referred to, those in column 3 are the results obtained with a similar machine of larger dimensions. The work is expressed in kilogrammes.

Number of Ruhmkorff elements joined up for intensity. (1.)	Work developed by the small Deprez motor. (2.)	Work developed by the large Deprez motor. (3.)
1	0·27	0·40
2	0·57	0·70
3	0·87	1·10
4	1·10	1·50
5	„	1·90
6	„	2·30
7	„	2·70

These results differ greatly from those obtained with the electric motors experimented on in 1855 by M. Becquerel. The results are so satisfactory that we will state to what they are due:

1st. The replacement of oscillating movements by rotatory ones, which enables greater speed to be obtained.

2nd. The longitudinal arrangement of the armature replacing the transverse position. This change, which constitutes the true perfection carried out in the Siemens' apparatus, utilises all the power of the magnet and renders the motor much lighter with equal power.

3rd. The easy adjustment of the position of the contact brushes, which enables the best position for maximum power to be obtained.

4th. The regulator of velocity by centrifugal force prevents the machine from overrunning itself.

Let us add in conclusion that the motor is *reversible*, that is to say, if we turn the handle shown

in the fig. the machine will generate a current the force of which is equal to three Bunsen elements with the small model. From this point of view it will be very useful in laboratories or places where battery power is only required for a short time. It is sufficient to turn the handle in order to produce a current of electricity sufficiently powerful to repeat most of the experiments with dynamic electricity, such as chemical effects, calorific effects, electro-magnetism, induction, &c. Considered as an electric motor, the apparatus of M. Marcel Deprez will be susceptible of a great number of applications when electricity comes to be laid on for domestic purposes, or when an economical battery is discovered, which latter, however, seems at present hardly probable.—*La Nature.*

SHIP LIGHTING BY ELECTRICITY.

DURING the recent trial trip of the new steel ship *Mendoza*, built for the Pacific Steam Navigation Company by Messrs. Napier and Sons, of Glasgow, an interesting trial of the electric light was made in the saloon of that vessel. The apparatus was fitted temporarily on board, and consisted of a Gramme machine and Serrin lamp, which for some time past have been used to illuminate a portion of Messrs. Napier's works. It is stated that the saloon was very successfully lighted by this means. This is, we believe, the first example of the electric light being used on board a merchant steamer for interior lighting, and its success will, no doubt, lead to further experiments in the same direction being made. What is required for the purpose is a number of lights of comparatively small power, say 50 to 100 candles. We are informed that the British Electric Light Company are giving considerable attention to this branch of lighting, and are engaged in constructing various types of Gramme machines with a view to obtaining the best results in this direction.

Notes.

THE ELECTRIC LIGHT.—M. Berly, of the Société Jablochkoff, has recently arranged with Mr. Nicoll, of Regent Street, for four lights of that system in addition to the Serrin lamp previously used in the establishment of that gentleman, the whole to be worked from an Otto gas-engine. Messrs. Crocker and Sons, of Friday Street, are more and more pleased with the twenty lights they have established on their premises. Two other large firms, whose names we may not at present mention, are also about following the example of the Messrs. Crocker. In London the light has not come into use for the inside lighting of theatres, possibly on account of the cheapness of gas in this country; but at the Bellecourt Theatre, Lyons, there are 52 Jablochkoff lights—8 in the central chandelier, 4 in the auditorium proper, and 12 on the stage; the remainder in the corridor, tower, and basement. These are all worked from three Gramme batteries, driven by two 25-horse power engines. The Chatelaine, Paris, has 16 lights—4 outside, 8 in the auditorium, and 4 on the stage. The Café Concert La Scala, has also 16 lights, and the Grand Theatre, San Francisco, is likewise lit by Jablochkoff candles. In Persia the Shah has installed the same system, and inaugurated the lighting by himself closing the circuit.

DIVIDING THE ELECTRIC LIGHT.—In the *Telegraphic Journal* for July 15th we illustrated the plan of Messrs. Molera and Cebrian for distributing the electric light by means of lenses and reflectors. The following facts constitute some late information on the subject, and on the result of a recent experiment:—"The fountain light used was a 4,000-candle electric light, enclosed in a chamber, on one side of which was a 24-inch Fresnel lens, from which beams are projected in parallel lines. The whole or any number of these lines, or rays of light, may be collected on a mirror or reflecting surface of any kind, and distributed in any greater or less intensity through secondary lenses without additional loss. In the experiment hardly one-half of the main light was collected, but it was divided into 16 separate lights, equal to 80 candles each. The secondary lenses were of small size, and situated in the ceiling, the light being thrown down. The quality of the light was equal to pure diffused daylight—in fact, several hundred shades of silk, arranged upon cards and placed side by side, could be distinguished as readily as by sunlight. Had it not been for the loss of light, occasioned by the size of the reflecting mirrors, we believe the light could have been subdivided to its fullest extent, and into at least 50 separate lights. The whole light from the main lamp can be divided and subdivided, and distributed down to a single ray even, at pleasure. The dispersing lenses and reflectors are arranged inside the building so as to illuminate every part without any obscure corners. In the open air the rays of light thrown upon objects over a mile away in the darkness of night brought them into view with startling distinctness."

THE Siemens electric light at the British Museum gives general satisfaction. There is little or no objectionable hissing now; but there are some readers who complain of a slight inconstancy in the illumination. The reading room is by its aid kept open till 7 p.m. each evening.

AT the recent sale of the Electric Lighting Company's effects the sums realised were ridiculously low. Some lots fetched less than $\frac{1}{4}$th of their ordinary price.

THE LONTIN AND SIEMENS ELECTRIC LIGHTS are competing for favour in a public display at the Palais de l'Industrie, Paris, where they are to be seen illuminating the same hall.

THE NEW FRENCH ATLANTIC CABLE has now been completed by the *Faraday* between Brest and St. Pierre; and the St. Pierre to Cape Cod section is now being laid.

BROOKE'S UNDERGROUND CONDUCTORS have been tried along a railway between Bruges and Ostend, Belgium. The tube is 1,200 feet long, 2 inches in diameter, and contains 21 conductors. The electricians of the Belgian Telegraphic Administration have found the insulation to be five hundred million Siemens' units per mile. The inductive capacity was only about one-thirteenth of that of ordinary Belgian submarine cables, and the proportion of specific inductive capacity, compared with that of gutta-percha, was much less. It is stated that inductive disturbances do not affect the Gower telephone when joined up in circuit with one of the wires, although the others in the same tube are busy working with the Hughes instrument; but as the Gower circuit would seem to be composed of a going

and returning wire twisted together, this is hardly to be wondered at. Mr. Brookes has gone to Paris to submit his system to the French Telegraphic Administration. Our readers are probably aware that Brookes' system is also being tested at the Silvertown Works.

THE MICROPHONE FOR DEAF PERSONS was brought before the Société de Biologie by M. Paul Bert recently, but it did not work. M. Alf. Niaudet, however, informs us that M. d'Arsonval is about to show him the instrument, and he will let us hear the result.

THE NEW AMERICAN UNION TELEGRAPHIC COMPANY has formed an exclusive connection with the New French Cable Company; besides having a working agreement with the Dominion Telegraph Company of Canada. The latter company has reduced its tariff to 20 cents for 10 words, out of unfriendly rivalry to the Montreal Telegraphic Company.

A CHAMBRE SYNDICALE of Electricity has been established in Paris, and now numbers over 75 members.

THE AMICABLE DINNER of the Paris scientific press, which took place recently, inaugurates a custom which we should be glad to see adoped in London.

A NEW PHONOGRAPH.—Edison's phonograph, as now constructed, is in several important respects defective. For example, the time of recording the sound on the apparatus is proportioned to the size of the barrel. The necessity of wrapping the barrel with foil does not permit of the conservation of speech, and by reason of its flimsy character only allows of several repetitions. With a view of overcoming these drawbacks, a young French professor, M. Custane Gamard, has, we are told, constructed a modified instrument, in which the speech is impressed along a straight, instead of a curving, line. This apparatus consists of a horizontal plate, upon which a series of chariots can be placed; movement is given by means of a rack fixed to their lower part and gearing with a toothed wheel furnished with a crank. At the centre of each of the chariots is placed at will a little copper rule, to which is attached a light leaf of copper or silver. Above this system is mounted the vibrating plate, furnished with its probe or stylus. On speaking into this new phonograph on putting the first chariot in motion the voice engraves itself on the metal leaf; and it is only necessary to employ succeeding chariots in order to record the entire discourse. The second difficulty has also been overcome by M. Gamard, for the moveable rules to which the metal leaf is fixed can be detached from the chariots supporting them. To make them reproduce the sounds which have been registered on them, it suffices to replace them in the apparatus. The substitution of copper or silver leaf for tinfoil renders the matrix capable of preserving the speech for a long time, and giving many reproductions. The rigidity of these leaves prevents their employment in the American phonograph. M. Gamard's improvements are an advance towards the date when the Edison phonograph will cease to be a scientific curiosity, and become of some practical value.

THE CANTOR LECTURES.—The second course of these lectures will be on the "Manufacture of India Rubber and Gutta Percha," by Thomas Bolas, F.C.S.; and we observe that on the ordinary meeting for December 3rd, Dr. Sylvanus Thompson will discourse on "Apprenticeships Scientific and Unscientific."

PRIZE ESSAYS.—Among the subjects which are eligible for the next prize competition of the Institution of Civil Engineers, we observe the following: "The Relative Advantages of Steam, Heated Air, Gas, Water, and Electricity as the Motive-Power in Small Engines," and "The Employment of the Electric Current for the Transmission of Sound, and the Use of the Telephone for Practical Purposes."

TAMING HORSES BY ELECTRICITY.—The Paris Omnibus Company now administer electric shocks as a check upon restive and gibbing horses. The current is excited by a small Clarke induction machine, and is led by wires along the reins to the bit of the horse whose evil propensity is well-known, When the horse is stubborn or vicious, the driver presses a button in the apparatus beside him on the box, and closes the electric current. The instant the animal feels the mysterious sensation in his mouth, he is said to submit at once. The effect appears to be a simple numbness or uneasiness rather than actual pain, and is probably more humane than curb or whipping.

LE SOLEIL ELECTRIQUE.—Our French contemporary, *L'Electricité*, in a review of Lontin's electric lighting apparatus, exhibited at the Palais de l'Industrie, Paris, gives a description of an illuminating device termed an electric sun. It is formed of four carbon electrodes radiating from a common centre, but without touching there. Four separate currents are sent through these carbons. The first enters by the carbon A, and leaves by B; the second enters by A, and leaves by C; the third enters by C, and leaves by D; the fourth enters by A, and leaves by D; thus forming a spherical arc, and giving a complete circle of dazzling light from every point of view, resembling the solar disc itself.

THE ELECTRIC LIGHT UNDER WATER.—The German military have been trying submerged electric lights in the Rhine for detecting torpedoes moored under water. A transparent globe enclosing an electric lamp was sunk 60 metres below the surface, and by means of the current from a generator on shore it served to illuminate the surrounding water and bottom. For engineering surveys, and for attracting fish, these subaqueous lights may be of considerable use.

GOWER'S TELEPHONE has been adopted in Paris to connect the office of the *Temps* newspaper with the editor's home.

EDISON'S TELEPHONE has been adopted by the Paris *Figaro*, and seats for theatres may be secured at the *Figaro* office by telephone without the necessity of going to the theatre itself. Perhaps our own telephone companies will take the hint, and put themselves into telephonic communication with the leading theatres for this purpose. Edison's telephone will probably also be installed in the French Senate and Chamber of Deputies. During the ensuing session it is stated that the telephone is to be employed in reporting the parliamentary debates for our own *Times*, and the type-setter will be able to set them up as they are spoken to him, thereby saving the trouble of transcription from the short-hand report, and gaining some 40 minutes in point of time, that is, enabling the paper to publish some 40 minutes more of the proceedings; we are unable to understand, however, how type can be set up as rapidly as a speech can be delivered.

A LIQUID RHEOSTAT.—Mr. F. J. Smith describes in a recent number of *Nature* a simple pressure rheostat

made by taking an elastic tube filled with a weak solution of salt in water, and subjecting it to the adjustible pressure of a screw at its middle. A current passing through the solution meets with resistance proportioned to the pressure of the screw. The tube can also be used as a telephone transmitter, by providing it with a diaphragm, which bears on the side of the tube like the screw under the impulses of the voice.

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ELECTRIC DISCHARGE IN GASES.—Messrs. Warren De la Rue and H. W. Müller, from a number of experiments on the spark given by their chloride of silver battery in rarefied gases under pressure, have arrived at the following conclusions:—

1. For each gas there is a minimum pressure corresponding to a minimum resistance to the passage of the spark. If the pressure be diminished below this minimum the resistance rapidly increases.
2. There does not seem to be any condensation or dilatation of the gaseous medium in the neighbourhood of the electrodes.
3. The discharge is accompanied by a sudden expansion of the gas, which does not appear to be simply due to heating. The expansion ceases instantly with the discharge.
4. The relation which exists between the pressure and the difference of potential necessary to produce the discharge between two plane surfaces, at a constant distance, may be represented by a hyperbolic curve; it is the same for the difference of potential and the explosive distance when the pressure is constant. The resistance to discharge between two plates varies as the number of interposed molecules.
5. The law does not hold for points. We have demonstrated formerly that under a constant pressure equal to an atmosphere the potential varies as the square root of the distances.

   With a constant battery of 11,000 elements the explosive distance has been sensibly in inverse ratio to the pressure from 1·5 mm. to 15 mm.
6. The electric arc and the stratified discharge in vacuo appear to be modifications of the same phenomenon.

Proceedings of Societies.

PHYSICAL SOCIETY.

THE meetings of this Society were resumed for the season, on Saturday, November 8, Professor W. G. ADAMS in the chair. The first paper was: "*On an Analogy between the Conductivity of Heat and the Induction Balance effect of Copper-Tin Alloys*," by W. Chandler Roberts, F.R.S. Mr. Roberts traced a remarkable resemblance between a curve representing the induction balance effect of the copper-tin alloys, published by him in June last, and the curve of Calvert and Johnston for the conductivity of heat, and, on the other hand, he showed that the induction curve does not agree with Mathiessen's curve for the electric conductivity of the same alloys. The author showed that the two alloys, which occupy critical points of the curve ($Sn\ Cu_3$ and $Sn\ Cu_4$), are of much interest. Possibly both are chemical combinations, and the wide difference in the position they occupy probably marks a difference of allotropic state. For the solution of such question, however, Mr. Roberts considered that we might look with confidence to Professor Hughes' beautiful instrument, which, he hoped, will also enable us to determine whether the relation for conductivity for heat and electricity is really as exact as it has hitherto been supposed to be.

As supplementary to this subject, Dr. O. J. LODGE stated that he had compared the conductivities of six bars of the tin-copper alloys, as measured by the balance and by the Wheatstone-Bridge, and found them to agree very closely on the whole. The Bridge results confirmed the resemblance traced by Mr. Roberts still more than the induction balance results.

Professor HUGHES expressed his opinion that existing tables of metal conductivity were erroneous. They disagreed among themselves, and the induction balance showed that it was impossible to get two pieces of the same metal exactly alike, hence the variation of specific conductivity results.

Professor AYRTON stated that at a former meeting he had suggested that the electric inertia of the different specimens of metals tested might cause the difference between the results obtained by the Wheatstone-Bridge and the induction balance. Mathematical calculation had since led him to the conclusion that the inductive effect is not proportional to the resistance of the metal tested, but to a *power* or exponential of the resistance.

Professor HUGHES replied that as the inductive effect of the metal was destroyed by cutting it so as to interrupt the circuit in it, it was reasonable to suppose that the said effect was due to induced currents circulating in the metal, and therefore was proportionate to the conductivity of the metal.

Captain ARMSTRONG exhibited a standard Daniell cell, formed of a porcelain vessel, with a porous partition, dividing it into two compartments. In one the zinc plate was immersed in a solution of sulphate of zinc, in the other the copper plate in a solution of sulphate of copper. To use the cell as a standard it was only necessary to connect the two liquids by a cotton string, moistened with water. This arrangement prevented mixing of the liquids, as the string could be withdrawn after use. The resistance was high, but it was a constant standard of electro-motive force.

Professor GUTHRIE mentioned that Professor Pirani, of Melbourne, in a letter to him, had signalled the fact that when a dilute acid was being electrolysed the positive electrode, if made of iron, became incandescent below the surface of the liquid. Professor Guthrie had found this to be true, not only for iron, but for other metals, and that it could hardly be due to oxidation, because it took place not only at the cuthode or positive electrode where oxygen was evolved, but also at the anode, where hydrogen was evolved. The incandesence appeared to him to be due to resistance. The author exhibited his experimental results, which, he did not doubt, had already been obtained by Professor Pirani himself. The positive electrode, when immersed in the electrolyte, was seen to get red-hot, and to wobble about. As the liquid heated the red glow became fainter. The negative electrode, on the other hand, emitted a bright light, accompanied by a spluttering noise. The light was tinged with the characteristic colour of the flame of the metal of which it was composed; in the case of a copper electrode, for example, it was greenish. These effects were shown by Professor Guthrie with iron, copper, and platinum electrodes, in dilute sulphuric and dilute nitric acid.

In reply to Professor ADAMS, Professor GUTHRIE said he had not yet examined the flame by the spectroscope; and, in reply to Professor FOSTER, he stated that the battery power used was 50 Groves cells. He asked for suggestions as to the cause of the phenomenon.

SOCIETY OF TELEGRAPH ENGINEERS.

AT the ordinary general meeting of the Society of Telegraph Engineers, held Nov. 12th, Major BATEMAN-CHAMPAIN (president) in the chair, the minutes of

the last meeting having been read and confirmed, the president stated that the reception of the delegates of the International Telegraph Conference held at South Kensington had been spoken of by the foreign delegates in high terms. The reception fund, which had been raised by voluntary subscription, was found to be in excess of the actual expenses by £200, and this sum it had been generally agreed by the subscribers to be devoted to the expenses in connection with the Ronald's Library; it being necessary, under the terms of the will, to have the books bound, the sum would be devoted chiefly to that purpose.

The debt incurred by the Society to meet the general expenses had been paid off by a loan from some members of the Society, the agreement being that the loan was to be paid off in annual instalments in seven years, but judicious management had enabled one-third of this debt to be paid off in the first year.

The president also alluded to the death of Sir W. Fothergill-Cooke, which took place in June of the present year, and stated that a memoir of that gentleman would appear in the proceedings of the Society.

A paper by Mr. J. R. PREECE, on "The Indo-European Telegraph Line between Teheran and Bushire," was then read by the secretary.

This line was incidentally referred to in a previous paper, which had appeared in the proceedings of the Society.

The Indo-European line was not erected without very great difficulty, arising from the obstacles offered by the Persian Government, and the continual interruptions to the line from wild tribes: the wires were continually cut, especially between Shiraz and Bushire. When the line was first opened it was arranged tha Persian and English clerks should work alternately, but this arrangement did not work at all satisfactorily, and a second line was commenced, which was to be under European control entirely. This line was finished in 1867, when Major R. M. Smith, R.E., announced its completion. A line was next commenced by Messrs. Siemens over the Caucasus.

The first of these lines gradually fell into decay, and in 1870 only about 1,000 insulators remained on the poles.

The final convention which was made with reference to an Indo-European line was arranged by Mr. Ronald Thomson and Major Champain, and was most satisfactorily carried out.

As regards the line with which the paper chiefly dealt, its length was about 800 miles, running for the first portion of its distance over a plain, and then over very hilly and broken country, with here and there a flat portion; sometimes spans of 200 to 1,200 yards were required. Bridle paths were carried along the whole distance of the line to enable it to be maintained. No. 5 wire was originally employed, but No. 3 was now adopted; there are three wires on the poles. The poles were partially of wood, partially of iron, the Siemens and the Hamilton pattern being both employed. A larger number of Siemens poles (2,000) were subsequently erected. The poles are 80 yards apart, as a rule, and are called "strainers" and "intermediates," they rise 14 feet above the ground, and the lowest wire is 11 feet off the ground; the wires are fixed at the straining poles by wedges in the insulators. They are not secured at the intermediate poles, but run through hooks. In the latest form of straining insulator a cam is used instead of a wedge, but it is stated not to be successful.

The line is under the management of 1 director, 2 superintendents, 6 inspectors, and 22 clerks. The head-quarters are Bushire, Shiraz, Isfahan, and Teheran. The linemen are natives, as are also the guards, who patrol the line continually.

Daily tests are made from 9 a.m. to 9.30 a.m., insulation and conductivity tests being taken, the latter are made with the lines looped. Tests are made first in one direction and then in the other.

The inspectors who examine the line have a portable sounder and battery, which they take with them. Faults are of frequent occurrence, but occur more seldom than formerly.

In the last year there were 5 faults, lasting 57 hours, which stopped communication entirely; 11 faults, lasting 113 hours, which stopped 2 wires; and 52 faults, lasting 497 hours, which stopped one wire only.

Contacts frequently occur from the wires breaking at the wedge; binding the wire at the intermediate poles did not prevent this.

Pole shooting by the Arabs use to be frequent, and poles were often broken by this. Hamilton poles bear this usage best. It was stated that as many as 60 bullet-holes have been found in a pole. Between 1874 and 1875, 214 poles were destroyed by this means, 88 between 1875 and 1876, 45 between 1876 and 1877, and 21 between 1877 and 1878.

Cairns of stone built around the poles partially stopped the practice.

Cracked sockets were frequently found, the cause of which was doubtful.

The insulation of the line averaged 350 megohms in fine weather, and 1 megohm in wet. During very foggy weather the leakage was sometimes so great that communication was entirely stopped.

It is intended to try Johnson and Phillips' insulators on the worst section.

The instruments first used were single current Morse, with polarised relays; but double current apparatus were afterwards adopted, with great advantage.

The static charge was very evident, and also the induction between wire and wire. To prevent the latter it was found necessary to put the two top insulators, which were formerly bolted together, further apart. The batteries employed were of the Minotto form. For locals, old Morse paper, in the place of sawdust, was found to be very efficient, the resistance of the battery being very low.

In 1872 Fahie's duplex system was tried successfully between Teheran and Shiraz, but was not found necessary.

In the discussion which followed the reading of the paper—

MAJOR CHAMPAIN said that the overland route was selected in consequence of the failure of the first Red Sea cable. He pointed out that the most difficult part of the original route was between Bagdad and Fao, at which point the Indian Government were to have carried on the line: 500 miles passed through desert country peopled by hostile Arabs.

The first line was opened in 1864, but the working was not satisfactory. The line opened by Messrs. Siemens in 1870, passed via Belgium, Berlin, Warsaw, Odessa, Kertch, Tiflis, and Teheran, and was opened simultaneously with the British Indian Cable line. The delays on the Overland line were very slight.

Mr. C. F. VARLEY pointed out that the real cause of the failure of the first Red Sea cable was its being shipped in a dry state. He argued against the use of wedges for the insulators, as the hammers to drive them in must be detrimental to the porcelain cups. Cobwebs, he stated, did not lower the insulation of a line.

Mr. TREUENFELD considered that the wedge insulators answered satisfactorily, and were not liable to breakage.

At the conclusion of the discussion a vote of thanks was proposed by Mr. LATIMER CLARK and seconded by Mr. JOHNSON.

New Patents—1879.

4346. "Galvanic Batteries." R. C. ANDERSON. Dated Oct. 24.

4354. "Improvements in or applicable to electric lamps." A. S. HICKLEY. Dated Oct. 25.

4400. "Improvements in and relating to the generating, storing, and application or utilisation of electricity, and to apparatus therefore chiefly designated for lighting, telegraphic, and plating purposes." W. R. LAKE (communicated by E. J. Houston and E. Thomson). Dated Oct. 29.

4404. "Electric Batteries." A. V. NEWTON (communicated by F. Tommasi). Dated Oct. 29.

4428. "Electrical apparatus." E. G. BREWER (communicated by E. A. Chambrier). Dated Oct. 30.

4440. "Telephones." J. H. JOHNSON (communicated by C. Ader). Dated Oct. 31.

4456. "Apparatus for containing and protecting surface and underground telegraphic wires." J. T. KING (communicated by C. Linford). Dated Nov. 1.

4534. "Dynamo-electric and electro-dynamic machines." C. W. Siemens. Dated Nov. 6.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1879.

926. "Electro-dynamic and dynamo-electric apparatus." M. P. W. BOULTON. Dated March 8. To avoid the small distance over which any given magnetic poles act in electro-motors, a pair of electro-magnets are connected together by eccentrics, &c., that they both move or rotate in the same direction, while the distance between them changes, now increasing, now diminishing. When this arrangement is used for production of motion from electricity the currents in the electro-magnets are directed by a suitable commutator in such a way that the magnets attract one another while they are approaching, and repel one another when they are separating. Thus the mutual attraction and repulsion of the magnets are exerted through a stroke of as great length as may be desired, while the magnet poles are kept close together through the whole of it.

935. "Galvanic batteries." L. A. BRASSEUR, O. A. E. DEJAER, Brussels. Dated March 10. 8d. Preventing polarisation of battery plates by rotating them so as to expose fresh surface to the solution. The battery is to be used for lighting a buoy by means of a luminous Geissler tube, and the motor is an Archimedean screw put in motion by the tide.

947. "Apparatus for electric lighting." H. J. HADDAN (communicated by C. F. Brush, Cleveland, Ohio, U. S.). Dated March 11. 8d. This consists in an electric lamp in which the upper carbon is provided with a mechanism which alternately keeps it stationary and allows it to advance by gravity, while the lower carbon is fed by the result and force of magnetism caused by the passage of the current through a coil in the main circuit and a coil in a shunt circuit. The lower carbon-holder is attached to a core, movable under the magnetic attraction of the main current, and sometimes of both it and the shunt current.

960. "Dynamo-electric machines." LOUIS SIMON. Dated March 11. 6d. To reduce the warming of the armature it is made flat, and composed of several sheet discs magnetically insulated from each other; both side faces as well as outside being brought under the influence of the magnet poles. These poles are arranged with their highest intensity of magnetism directly opposite the side faces of the ring to act on it. The electro-magnets cover over two-thirds of the whole surface of the armature, making opposite polarity at opposite points of the ring.

1015. "Galvanic batteries." T. J. HOWELL. Dated March 14. 6d. This cell consists of an outer glazed vessel and an inner porous pot. The latter contains zinc, mercury, ammonia, and water; the former, sulphuric or nitric acid; while between the two cells is placed broken carbon and peroxide of manganese and white manganese. This cell, it is claimed, may be easily cleaned without disturbing the manganese.

1122. "Electric light." G. L. FOX. Dated March 20. 2d. This consists in making a continuous electrode of plumbago mixed with a bad conductor like magnesia, zirconia, lime, steatite, &c., in a proportion giving a resistance suitable to the electromotive force of the current. With a current of 140 volts. E.M.F., the incandescent electrode should have a resistance of 300 B.A. units. (*Not proceeded with.*)

1175 "Electric candles." JOHN IMRAY (communicated by the Société Générale, Paris). Dated March 24. 6d. Instead of the parallel candles of the Jablochkoff candle two metallic wires are, according to this invention, placed parallel to one another, or slightly inclined, each being entirely enclosed in an insulating material consisting chiefly of mineral carbonaceous matter such as anthracite, which is moulded so as to surround the two wires in cylindrical form, with a thin middle rib uniting the two cylindrical coatings. Thus is formed a cylindrical candle with two metallic wicks which, throughout the body of the candle, are insulated from each other, but which at the summit are electrically connected by the fused matter. The wire wicks and their composition are consumed in the arc. Magnesia, agglomerated with chloride of magnesium round the wires, gives a brilliant lustre owing to separation of the magnesium. The tip of the candle is furnished with a kindler, or match of carbon paste; and zinc is blended with the composition to facilitate rekindling if the candle goes out. Instead of zinc or metallic powder, metallic oxides may be used for this purpose.

1181. "Iron telegraph posts." F. C. GLASER. Dated March 25. 4d. This consists in making the posts of a trough-shaped cross-section, giving less weight, greater strength, and more surface for fitting cross-arms. (*Not proceeded with.*)

1203. "Coating the surface of moulds with black lead for electrotyping." E. A. CLOWES and J. BATEY. Dated March 26. 2d. A flat-faced brush is caused to vibrate rapidly by mechanism, and the moulds are placed on a table which is moved by a screw so as to bring them slowly under the brush, which is fed with black lead from a hopper. (*Not proceeded with.*)

1207. "Producing electric lights." T. A. DILLON. Dated March 26. 4d. To a central steam or gas meter the author attaches a strong air-reservoir, with air-compressing pump driven by it, and from this reservoir the air is led by a branching system of pipes to streets, factories, &c., where it actuates small air-engines and dynamo-machines, which feed electric lamps. Waste power, such as waste steam, tidal or river power, wind, can be used to store the compressed air-reservoir.

1229. "Apparatus for raising submerged r operty." H. W. HEMSWORTH. Dated March 28. 2d. Pontoon fitted with grappling arms is lowered, and after these have taken hold of the object to be raised, cable, anchor, or ship, air is pumped into the pontoon by

means of pipes, and the buoyancy of the latter raises the cable, &c., to the surface. (*Not proceeded with.*)

1242. "Electric telegraphs." E. A. COWPER. Dated March 28. 6d. This relates to improvements in Cowper's writing telegraph (patent 2385, 1878), by which, instead of making the movements of the style introduce a varying resistance into the circuit, it is made to vary the strength of the current by bringing into the same a varying number of battery cells, or parts of cells. Also, instead of employing battery currents, it proposes to use induced currents generated by magnetic cores movable in solenoids.

General Science.

A NEW THEORY OF SEA-SICKNESS.—Nitrite of amyl has proved itself an alleviator of sea-sickness, and this circumstance has led Dr. Henry Naylor, of Edinburgh, to conclude that the organic cause of this distressing malady is cerebral anæmia, or insufficiency of blood in the head. According to this view, the rapid swinging of the vessel and the body with it irritates the eyes and vision, and this by reflex action produces a spasm of the cerebral capillaries, which explains the feeling of faintness and giddiness that suddenly comes on as the vessel gives a big swing. The sudden emptying of the cerebral vessels causes the stomach to sympathise, and efforts to vomit are the result. These symptoms are most violent when the subject sits or stands *with his eyes open*. If he lies down the change of position relieves the anæmia, the faintness and giddiness pass away, and the sickness ceases. Occasionally even the recumbent attitude does not give relief if the eyes are kept open, but when these are shut the symptoms are not at all felt. Dr. Naylor has known ladies who were never comfortable at sea until they lay down with their eyes shut, and then they could even take their meals. The anæmic theory is supported by the fact that brandy and other stimulants give considerable relief for a time, which would not be the case did cerebral congestion have to do with sea-sickness. Prolonged sea-sickness is explicable under this theory by a weakening of the action of the heart, which keeps up the cerebral anæmia and as a consequence the sickness. Dr. Naylor states that nitrite of amyl usually does good as a remedy for sea-sickness if resorted to at once, for being an anti-spasmodic, it relieves the spasm of the cerebral vessels, and enables the brain to fill itself with blood. But if it fails the persistent sickness sets in owing to the weakening of the power of the heart, and for this alcoholic stimulants in small doses, frequently repeated, give great relief.

REFRIGERATED STORE-HOUSES.—A large artificially cooled store-house has been erected at Boston by the Massachusetts Chemical Refrigerating Company, for the storage of all kinds of provisions perishable in warm air. The store-house is built so as to be as nearly as possible insensible to outside atmospheric changes, then the heated gases inside are drawn off by a powerful exhaust fan, while cold, pure, and dry air is supplied in its place. The process is a continuous one, so that a constant circulation of the refrigerated air is kept up throughout the various compartments of the store. Evaporation of ammonia is the means employed to produce the artificial cold.

The building referred to contains 94,000 cubic feet of space, some 80,000 of which are now occupied by no less than 10,000 packages of butter, 300 barrels of beef, 650 cases of pork, 3,500 dozen eggs, 7,800 lbs. dried apples, and about two tons of cheese, the property of different produce and commission merchants. It is expected that similar stores will soon be put up in various American mercantile centres, and that refrigerated steamers and railway cars will be employed for the traffic between them. The Swedish Government also introduced ice-refrigerated waggons on the State railways last summer for the transport of provisions.

GAUMET'S TELEMETER.—A neat little pocket telemeter invented by M. Gaumet, a French lieutenant, was illustrated in *La Nature* for Oct. 1. It is provided with two mirrors like a pocket sextant for surveying, and in order to determine the distance of an inaccessible point it is only necessary to measure a short base line of twenty metres and take two sights at the end of it, then refer to a table provided with the instrument for the distance in question.

THE WRITING BALL, or Danish Type-writer, of Sofus E. Holten, which was awarded a gold medal at the recent Paris Exhibition, is now manufactured by the India Rubber, Gutta Percha, and Telegraph Works Company, Silvertown. It is worked by finger keys arranged round the top of a ball or spherical surface, and produces Roman characters. By using carbonic paper a number of copies may be made at one operation; and the writing may also be transferred to a lithographic stone and printed in the ordinary manner. Compared with other type-writers it has a more direct action, and carries more type.

LEWIS' PATENT CHEQUES FOR PREVENTING FRAUD.—We would draw the attention of our readers to these useful cheque-books, whereby a forgery if not rendered impossible is at least limited to a certain amount which is not deadly. Thus if a forger obtains a cheque for £9, he cannot possibly palm it off for £900 by the mere addition of cyphers, because it will express on its own face by a simple device that it is not current for any sum over £20.

EXPERIMENTS ON IRON WIRE.—From the experiments by Mr. J. T. Bottomley, a report on which was read before the British Association at Sheffield, it seems that the prolonged application of stress has a very remarkable effect in increasing the strength of soft iron wire. Comparing the breaking weights for a wire quickly broken with those for the same wire slowly broken, it is found that in the latter case the strength of the wire is from 2 to 10 per cent. higher than in the former, and is on the average about 5 or 6 per cent. higher. The result as to elongation is even more remarkable, and was certainly more unexpected. In the case of the wire quickly drawn out, the elongation is, on the average, more than three times as great as in the case of the wire drawn out slowly. There are two wires for which the breaking weights and elongations are given in the tables accompanying the report, both of them "bright" wires, which showed this difference very remarkably. They broke without showing any special peculiarity as to breaking weight, and without known difference as to treatment, except in the time during which the application of the breaking weight was made. One of them broke with 44 lbs., the experiment lasting one hour and a half; the other with 47 lbs., the time occupied in applying the weight being thirty-nine days. The former were drawn out by 28·5 per cent. on its original length, the latter by only 4·79 per cent. It was found during the breaking of the wires slowly—several months—that the wire becomes alternately more yielding and less yielding to stress applied. Thus, from weights applied gradually between 28 lbs. and 31 lbs. or 32 lbs., there is

very little yielding and very little elongation of the wire. For equal additions of weight between 33 lbs. and about 37 lbs. the elongation is very great. After 37 lbs. have been put on, the wire seems to get stiff again, till a weight of about 40 lbs. has been applied. Then there is rapid running down till 45 lbs. has been reached. The wire then becomes stiff again, and often remains so till it breaks.

PIKE'S PEAK.—The United States Signal Service Station at Pike's Peak is the highest signal station in the world. It was opened in the month of September, 1873. The point is wonderfully favoured by nature for the study of astronomy and meteorology. The rarity of the atmosphere brings out a remarkable brilliancy and clearness to the stars and all the heavenly bodies. The nights are almost always cloudless, and cloudy days are the exception. Nine-tenths of the storms are below the Peak. The best and most complete report of the last total eclipse of the sun received at Washington was the report of Professor Loud, of Colorado College, from observations taken at Pike's Peak.

The signal station is under the charge of three sergeants. These officers are detailed from the United States army because of their special qualifications.

The summit of Pike's Peak contains 60 acres. It is 14,336 feet above the level of the sea. On the highest point of the summit stands the signal station, a rough stone building, 24 by 30, one storey in height. It is divided into four rooms—officers' room, kitchen, store-room, and wood-room. And here in this bleak spot, nearly 20 miles from the habitations of man, though three miles nearer the heavenly regions than most parts of New England, these men live the larger part of the year. The station is three miles from the timber line, where the greater part of vegetation ceases. Short grass, tufted with delicate Alpine flowers, struggles for an existence against the frigidity of the atmosphere, and creeps towards the mountain top; but there are hundreds of acres of cold grey and reddish rocks where not a vestige of verdure exists.

Like the dwellers of the Arctic regions, the inhabitants of Pike's Peak have but two seasons—summer and winter. Two months of summer—August and September—and 10 long, cold months of winter. During the summer of 1878 upwards of 900 people, in parties of from five to thirty, visited the Peak, among them many ladies. To behold a sunrise from the Peak visitors often remain overnight at the station.

The duties of the officers are various. Seven observations are taken daily; all storms are closely watched and each special and distinctive characteristic duly recorded. Monthly reports of these records are sent to headquarters at Washington. A Government office at Pike's Peak is no sinecure, for the officer must buffet all storms and brave all weathers. Occasionally an electric storm visits the Peak. There is but little thunder accompanying these storms, but the mountain seems all on fire.

The summer months are occupied in preparing for the long siege of winter. During the months of August and September upwards of 3,000 pounds of the usual variety of family stores, and about 25 cords of firewood, are snugly stowed away. These are all carried to the Peak in small quantities on the backs of donkeys.

THE COMPOUND NATURE OF THE ELEMENTS.—Continuing my researches into the nature of the so-called elements, I have found that when carefully distilled metallic sodium was condensed in a capillary tube, placed in a retort, and heated in a Sprengel vacuum, it gave off 20 times its volume of hydrogen. Phosphorus, carefully dried and submitted to the same treatment, gave off 70 volumes of a gas which appeared to consist chiefly of hydrogen. Although it gave some of the lines of phosporus, it was not PH_3, as it had no action on solution of cupric sulphate. A specimen of magnesium, carefully purified by Messrs. Johnson and Matthey, gave me a magnificent series of coloured phenomena. The hydrogen lines first appeared, then the D line—not the sodium line, be it understood, for the green line was absent—and, lastly, the green line of magnesium (*b*), and then, as the temperature was increased, mixtures of all these lines, with the blue line, the D line being always the most brilliant. In this experiment only two volumes of hydrogen were collected. From gallium and arsenic no gas of any kind was obtained. From sulphur and some of its compounds sulphurous anhydride was always obtained. From indium hydrogen was given off in vacuo before heating, while from lithium no less than 100 volumes of hydrogen were given off. The conditions of the experiments were always the same, the only variable being the substance itself.—*Norman Lockyer.*

The Telegraph Construction and Maintenance Company's ship *Kangaroo* will shortly sail with 120 miles of cable for the New Zealand Government. The s.s. *Scotia*, belonging to the same company, has taken on board the remaining portion of the Cape cable, and has left the Thames for Aden. The laying of this cable will be completed next month. To obtain the best course for the bed of the cable no less than 118 soundings have been taken between Zanzibar and Aden.

We are informed that the Direct Spanish Cable *via* Bilbao has been repaired, and is now open for traffic.

The Western Union Telegraph Company's report for the year ending June 30th, 1879, shows a nett profit of 4,800,440 dollars.

The following are the final quotations of telegraphs for 12th Nov.:—Anglo-American, Limited, 55½-56½; Ditto, Preferred, 81½-82½; Ditto, Deferred, 31½-32½; Brazilian Submarine, Limited, 7⅛-7⅜; Cuba, Limited, 8-8½; Cuba, Limited, 10 per cent. Preference, 15-16; Direct Spanish, Limited, 1⅞-2¼; Direct Spanish, 10 per cent. Preference, 11½-11⅞; Direct United States Cable, Limited, 1877, 10⅜--10⅝; Eastern, Limited, 8½-8⅝; Eastern, 6 per cent. Debentures repayable Oct., 1883, 102-105; Eastern 5 per cent. Debentures repayable Aug., 1878, 103-105; Eastern, 6 per cent. Preference, 12-12½; Eastern Extension, Australasian and China, Limited, 8⅛-8⅜; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 1-2 pm; Ditto, registered, repayable 1900, 1-2 pm; German Union Telegraph and Trust, 7¼-7⅜; Globe Telegraph and Trust, Limited, 4⅞-5⅛; Globe, 6 per cent. Preference, 11-11¼; Great Northern, 8½-8⅝; Indo-European, Limited, 22½-23½; Mediterranean Extension, Limited, 2⅝-3¼; Mediterranean Extension, 8 per cent. Preference, 9¼-10¼; Reuter's Limited, 9-10; Submarine, 227-232; Submarine Scrip, 2-2¼; West Coast of America, Limited, 1-1⅛; West India and Panama, Limited, 1⅛-1⅜; Ditto, 6 per cent. First Preference 7¼-7⅝; Ditto, ditto, Second Preference, 6⅜-7¼; Western and Brazilian, Limited, 4⅛-4⅜; Ditto, 6 per cent. Debentures "A," 98-102, Ditto, ditto, ditto, "B," 96-100; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 105-107; Telegraph Construction and Maintenance, Limited, 35-36; Ditto, 6 per cent. Bonds, 106-108 Ditto, Second Bonus Trust Certificates, 2⅝-3; India Rubber Co., 12⅞-13¼; Ditto, 6 per cent. Debenture, 104-108.